INHERITANCE OF KERNEL ROW NUMBER IN CORN

BY

DENTON EUGENE ALEXANDER

B.S., University of Illinois, 1941

AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN AGRONOMY
IN THE GRADUATE COLLEGE OF THE UNIVERSITY
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INHERITANCE OF KERNEL ROW NUMBER IN CORN

Despite the fact that yields of corn have been greatly increased during the past 20 years by breeding, little is known about the inheritance of quantitative character in this crop. Quantitative characters are difficult to study: they are usually controlled by many genes that interact in different ways; classes in segregating generations are not distinct, i.e., variation is continuous; environment produces effects that are confounded with genetic effects; and different genotypes may produce highly similar phenotypes.

The primary purpose of this investigation was to establish the nature of the factors, genetic or environmental, or both, that are responsible for diversity of row number within five long-established inbred lines of corn. Secondly, observations on the inheritance of row number were to be made and interpretations made of these data.

MATERIALS AND METHODS

In 1946, approximately 40 ears were selected at random from standard stocks of five dent inbred lines (Iowa L289, Indiana WF9, Illinois 90, Illinois R4, USDA CI187-2) that were maintained by the Agronomy Department of the University of Illinois. These ears were the progenitors of separate families, henceforth called "sub-strains", and were perpetuated by selfing. Selection for row number was not practiced during the course of the experiment.

Counts were made on primordium number (two rows) of uppermost ears of large plantings of each sub-strain in 1948. F_1 crosses were produced during the summer of 1948 and some F_2 and backcross generations were made in the greenhouse in the winter of 1948-49. Parents, F_1, F_2 and some backcross progenies, were planted in randomized block plantings in 1949 and primordium number determined. Counting methods which attained high accuracy are described.

Environmental effects were evaluated by counting the primordia on the uppermost five ears of inbred and hybrid plants that had been repeatedly cut off at ground level after emergence. The same counts were made on check (untreated) plots. Data was analyzed by the analysis of variance method.

General observations on sub-strain performance. Side-by-side plantings of sub-strains of each of the five inbred lines strikingly demonstrated the close similarity in appearance. Some differences in the date and amount of pollen shedding, vigor, and erectness of the tassel were observed in WF9. Differences in standability between sub-strains of inbred 187-2 were apparent.

Intra-inbred variation in primordial number. Statistical treatment of primordial counts of sub-strains produced in 1948 indicated that highly significant differences existed between the means of certain sub-strains. A few sub-strains, their F_1's, F_2's, and some backcrosses were planted in 1949. Again differences were found between the means of certain sub-strains that were probably not due to chance.

F_1 generations, involving different sub-strains of the same inbred and a common tester, possessed significantly different means for primordial number, although two inconsistencies appeared. One inconsistency appeared in crosses utilizing Longfellow Flint (an open-pollinated variety) as common parent or tester.

Sub-strains that possessed different primordial means, produced F_2 and backcross generations that were also significantly different in three out of six observed series. Failure of the three F_2 series to perform differently can be perhaps attributed in one case to heterogeneity of the tester (Longfellow Flint) and in another to bias introduced through inability to classify accurately high row segregates because of ear rots.

Environmental effect upon primordial number. Repeated cutting-back of seedlings for extended periods was effective in reducing primordial number on the uppermost three ears in hybrids. Hybrids tended to perform alike under cut-back, i.e., variety-treatment interaction was not significant. Inbred-cut-back interaction was highly significant, however, indicating that inbreds do not tend to perform alike under cut-back. However, individual analyses of each individual inbred pointed out that the differences between the cut-back plots and the check plots were probably not due to chance.

Differences in vigor were noted between WF9 sub-strains. No

significant correlations were found between mean plant height and mean primordial number of individual sub-strains of WF9. Node diameter and number of primordia on ears borne at the same node were not correlated in L289, WF9, and 90, or in their three possible single crosses.

Intra-plant variation in primordial number. Hundreds of plants, belonging to three inbreds, an open-pollinated variety, and three hybrids, were classified for primordial number at the five uppermost ear-bearing nodes. Highest rowed ears were found to be associated with the uppermost nodes in inbreds L289 and 90, and in three single-cross hybrids. Highest rowed ears were randomly distributed from node to node in inbred WF9, and perhaps in Longfellow Flint.

DISCUSSION AND CONCLUSIONS

Evidence was presented that genetic heterogeneity for row number exists within the dent inbreds L289, WF9, 90, R4 and 187-2. Variation within sub-strains was attributed largely to environmental effects.

Strains of inbreds that possess still higher or lower row numbers than the means which characterize the extreme sub-strains already isolated, can probably be produced by crossing sub-strains, selfing, and selecting the transgressive segregates in the advanced generations. Extracted lines should be agronomically usable in the same combinations as the original inbred line.

If heterosis is assumed to be present when the F_1 mean exceeds the higher parent, then heterotic effects on row number were observed in only two F_1 generations out of the 20 F_1's observed. However, 16 of the 20 F_1's exceeded the mid-parent value (arithmetic mean).

Some sub-strains that produced significantly different numbers of primordia gave F_1 and F_2 generations that were not different so far as statistical treatment could discover. These inconsistencies were explained by one or more of the following factors:

1. Genes that differentiated the sub-strains were carried in the dominant condition by the common parent (tester), thus tending to obscure differences between the sub-strains.

2. Bias was introduced in the 187 x 90 F_2 generations because ear rots did not permit an accurate counting of the high-primordial segregates.

3. Longfellow Flint, which was a tester in a few crosses, showed evidence of previous outcrossing to dent corns and was segregating for row number.

No general conclusions were drawn as to the relative dominance of high or low rowedness. It was suggested, however, that inbred 90 possesses genes that raise row number in the homozygous recessive condition. Longfellow Flint may possess genes which depress primordial number in the homozygous recessive condition.

Each node of the corn plant, from the uppermost ear-bearing node to the basal node, produces an ear. Numbers of kernel rows on all the ears of the same plant are rarely, if ever, the same. Most inbreds and hybrids produce the highest-rowed ears at the uppermost nodes. Inbred WF9, however, produces highest-rowed ears randomly from node to node.

It was emphasized that a more complete knowledge of the structure of the ear is needed before precise genetic studies can be carried out on row number inheritance.

VITA

The writer was born on a farm near Potomac, Illinois, December 18, 1917. He attended rural and village elementary schools there, and in 1935, was graduated from the Potomac Township High School.

He matriculated at Illinois State Normal University that same year. In 1937 he was graduated with a major in rural education. During the academic years 1937-38 and 1938-39, he taught a rural school near Danville, Illinois.

In June, 1939, he entered the College of Agriculture of the University of Illinois, and majored in Agricultural Education. He received the Bachelor of Science in Agriculture in August, 1941, and was immediately employed by the U. S. Air Force as an instructor in the mechanic's training school at Chanute Field, Illinois. In 1942, he was transferred to Lincoln Air Base, Lincoln, Nebraska, where he assisted in establishing a new training school. He served there in a teacher-supervisory position until March, 1944.

In March, 1944, he was employed by the Tennessee Eastman Corporation for duty at the mass-spectographic uranium separation plant in Oak Ridge, Tennessee. He served there in various supervisory positions in production departments until January, 1947.

He entered the Graduate College of the University of Illinois in February, 1947. He was made special research assistant on the corn-breeding project shortly thereafter, and held that position until he was appointed fellow in Agronomy in September, 1949.

He is a member of Phi Kappa Phi, Sigma Xi, Gamma Sigma Delta and Alpha Tau Alpha.

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